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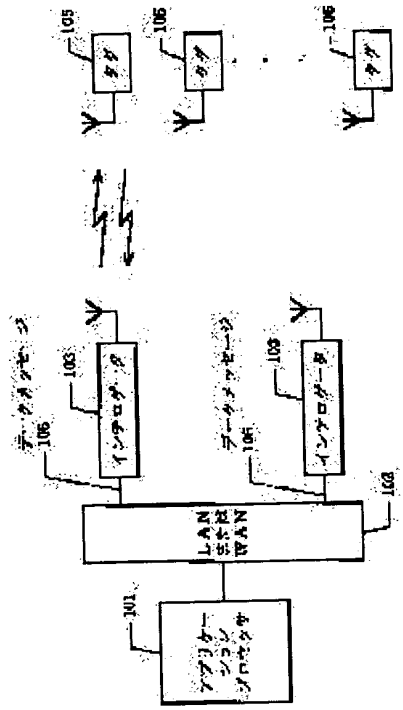
(54) RADIO COMMUNICATION SYSTEM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a short-distance radio data communication from a central control point (interrogator) to many inexpensive end points (tag).
SOLUTION: A tag 105 uses a modulation back-scatter method for a communication from the tag 105 to an interrogator 103. A new down-link protocol is used for data transmission from the interrogator 103 to the tag 105 and a new up-link protocol is used for data transmission from the tag 105 to the interrogator 103. Either protocol resends messages which are neither confirmed nor answered at random by using back-off/retry algorithm. The transmission capacity from the tag 105 to the interrogator 103 is improved more by using up-link subcarrier frequency-division multiplexing. In concrete, the tag 105 includes a sensor for temperature, smoke, or living body information and sends its output to the interrogator 103 with an up-link information signal.



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* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The radio communications system characterized by providing the following. A means to transmit a down link modulation radio signal. At least one in terrorism GETA which has a means to receive an up link radio signal. A means to receive the aforementioned down link modulation radio signal. The random transmitting means which repeats transmission of the modulation radio signal of at least one tag which has a means to restore to the aforementioned down link modulation radio signal, and to recover a down link information signal, and a means to transmit an up link radio signal using modulation back KYATTA, and the type which is chosen from the group which contains the aforementioned down link modulation radio signal and the aforementioned up link radio signal at least according to predetermined conditions, and which is different from each other at random time.
[Claim 2] the aforementioned random transmitting means -- the above -- the radio communications system according to claim 1 characterized by being arranged at one in terrorism GETA even if few, and repeating transmission of the aforementioned down link modulation radio signal at random time according to the predetermined conditions in this in terrorism GETA
[Claim 3] the aforementioned random transmitting means -- the above -- the radio communications system according to claim 1 characterized by being arranged at one tag even if few, and repeating transmission of the aforementioned up link radio signal at random time according to the predetermined conditions in this tag
[Claim 4] The aforementioned predetermined conditions are a radio communications system according to claim 2 characterized by being that there is no up link radio signal which answers the aforementioned down link modulation radio signal, and is received.
[Claim 5] The aforementioned predetermined conditions are a radio communications system according to claim 2 characterized by being that the up link radio signal which answers the aforementioned down link modulation radio signal, and is received is not received correctly.
[Claim 6] the above -- the radio communications system according to claim 2 characterized by having further a means to answer the up link radio signal which one in terrorism GETA received even if few, and to transmit a down link Acknowledgement signal
[Claim 7] The aforementioned up link radio signal is a radio communications system according to claim 2 characterized by being chosen from the group of the signal containing an up link Acknowledgement signal and an up link information modulation radio signal.
[Claim 8] the aforementioned random transmitting means -- the above -- the radio communications system according to claim 2 characterized by being arranged also at one tag even if few, and repeating transmission of the aforementioned up link radio signal at random time according to the predetermined conditions in this tag
[Claim 9] The aforementioned predetermined conditions are a radio communications system according to claim 3 characterized by being that there is no down link modulation radio signal which answers the aforementioned up link radio signal and is received.
[Claim 10] The aforementioned predetermined conditions are a radio communications system according to claim 3 characterized by being that the down link modulation radio signal which answers the aforementioned up link radio signal and is received is not received correctly.
[Claim 11] the above -- the radio communications system according to claim 3 characterized by having further a means to answer the down link modulation radio signal which received one tag even if few, and to transmit an up link Acknowledgement signal
[Claim 12] The aforementioned up link radio signal is a radio communications system according to claim 3 characterized by being chosen from the group of the signal containing an up link Acknowledgement signal and an up link information modulation radio signal.

[Claim 13] the aforementioned random transmitting means -- the above -- the radio communications system according to claim 3 characterized by being arranged also at one in terrorism GETA even if few, and repeating transmission of the aforementioned down link modulation radio signal at random time according to the predetermined conditions in this in terrorism GETA

[Claim 14] the above -- with a means to generate the subcarrier frequency chosen from the set of the subcarrier frequency in which one tag is possible at random even if few A means to modulate an up link information signal and to form a modulation subcarrier signal on the aforementioned subcarrier frequency, a means to transmit the aforementioned modulation subcarrier signal using modulation back KYATTA -- further -- having -- the above -- even if few, one in terrorism GETA The radio communications system according to claim 1 characterized by having further a means to receive the aforementioned modulation subcarrier signal, and a means to recover the aforementioned up link information signal from the aforementioned modulation subcarrier signal.

[Claim 15] the above -- the radio communications system according to claim 14 characterized by having further a means to restore to two or more up link information signals received during the period when one in terrorism GETA is the same even if few

[Claim 16] the above -- the radio communications system according to claim 1 characterized by having further a means to transmit two or more up link information signals before one tag receives a down link information signal, even if few

[Claim 17] the above -- the radio communications system according to claim 1 characterized by having further a means to transmit two or more down link information signals before one in terrorism GETA receives an up link information signal, even if few

[Claim 18] In terrorism GETA for radio communications systems characterized by the bird clapper from a means to transmit a down link modulation radio signal, and the means which repeats transmission of the aforementioned down link modulation radio signal at random time according to predetermined conditions.

[Claim 19] The aforementioned predetermined conditions are in terrorism GETA according to claim 18 characterized by being that there is no signal which answers the aforementioned down link modulation radio signal, and is received.

[Claim 20] In terrorism GETA according to claim 18 characterized by having further a means to receive two or more subcarrier ** <TXF FR=0001 HE=250 WI=080 LX=0200 LY=0300> numbers from two or more tags.

[Claim 21] In terrorism GETA according to claim 18 characterized by having further a means to transmit two or more down link information signals before receiving an up link information signal.

[Claim 22] In terrorism GETA according to claim 18 characterized by having further a means to receive the modulation back KYATTA signal containing the up link information signal modulated on the subcarrier signal chosen from the set of a possible subcarrier signal at random at random time.

[Claim 23] The tag for radio communications systems characterized by the bird clapper from a means to generate a subcarrier signal from the set of a possible subcarrier signal, a means to modulate an up link information signal and to generate a modulation subcarrier signal on the aforementioned subcarrier signal, and a means to transmit the aforementioned modulation subcarrier signal to random time using modulation back KYATTA.

[Claim 24] The aforementioned subcarrier signal is a tag according to claim 23 characterized by being chosen from the set of a possible subcarrier signal at random.

[Claim 25] The tag according to claim 23 characterized by including further the condition measuring circuit which measures one or more predetermined conditions chosen from the group containing temperature, smoke, and biological information.

[Claim 26] The tag according to claim 23 characterized by having further a means to measure temperature, and the means which includes a thermometry value in the aforementioned up link information signal.

[Claim 27] The tag according to claim 23 characterized by having further a means to detect existence of smoke, and the means which includes the result of smoke detection in the aforementioned up link information signal.

[Claim 28] The tag according to claim 23 characterized by having further a means to measure biological information, and the means which includes biological information measured value in the aforementioned up link information signal.

[Claim 29] How to operate the radio communications system containing at least one in terrorism GETA and at least one tag which are characterized by providing the following. This method is a step which transmits a down link modulation radio signal to at least one tag in in terrorism GETA. The step which receives the aforementioned down link modulation radio signal in a tag. The step which restores to the aforementioned down link modulation radio signal, and recovers a down link information signal. It consists of a step which transmits an up link radio signal using modulation back KYATTA, and a step which receives the aforementioned up link radio signal in aforementioned in terrorism GETA, the aforementioned method accepts further predetermined conditions, and they are the aforementioned down link modulation radio signal and the aforementioned up link radio signal at least.

[Claim 30] How to operate in terrorism GETA for radio communications systems characterized by the bird clapper from the step which transmits a down link modulation radio signal, and the step which repeats transmission of the aforementioned down link modulation radio signal at random time according to predetermined conditions.
[Claim 31] How to operate the tag for radio communications systems characterized by the bird clapper from the step which generates a subcarrier signal from the set of a possible subcarrier signal, the step which modulates an up link information signal and generates a modulation subcarrier signal on the aforementioned subcarrier signal, and the step which transmits the aforementioned modulation subcarrier signal to random time using modulation back KYATTA.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the system for the radio method which provides a cheap terminal (end point) with short distance communication especially about a radio method.
[0002]
[Description of the Prior Art] To develop the system which supports short distance wireless data transmission to a cheap terminal is desired. A radio frequency discernment (RFID (Radio Frequency IDentification)) method is a radio method which communicates with a radio transceiver (it is called in terrorism GETA.) between some cheap devices (it is called a tag.). RFID technology can be taken into consideration in development of the above systems. By the RFID method, in terrorism GETA communicates with a tag using a modulation radio signal, and a tag answers by the modulation radio signal. Generally, although the communication to a tag from in terrorism GETA uses an amplitude modulation radio signal, it restores to this easily. Generally the modulation back KYATTA (MBS (Modulated BackScatter)) method is used for communication to in terrorism GETA from a tag. In MBS, in terrorism GETA transmits a continuous wave (CW (Continuous-Wave)) radio signal to a tag. A tag modulates CW signal using MBS. In this case, when an antenna is electrically switched to the state of the reflector of RF radiation by the modulating signal of a tag from the state of the absorber of RF radiation, the data from a tag are encoded on CW radio signal. In terrorism GETA restores to the coming radio signal which was modulated, and decodes the data message of a tag. In the MBS communication to in terrorism GETA from a tag, with the conventional technology, the frequency shift keying (FSK) modulation and the phase shift keying (PSK) method are used for communication.
[0003]
[Problem(s) to be Solved by the Invention] The communication mode which makes possible short distance wireless data transmission to some cheap end points is needed. As an example, communication of the sensor data in the space where much electronic equipment exists can be considered. Such a situation may be produced in the cabin of a naval ship, and works environment in the control room of a industrial process in the electronic equipment in a military motor vehicle like a tank, and on the aircraft etc. In such application, the monitor of no less than the 1000 sensors may be carried out. although the present technology is supporting use of the sensor connected to the Chuo communication point with the cable, this has a bird clapper very at an expensive price [equipping] Moreover, this [its] is also expensive although the present technology is supporting use of the radio Local Area Network (WLAN (wireless Local Area Network)) which carries out central communication point interconnect of the end point.
[0004] Therefore, the cheap radio data network which makes possible data communication to many cheap devices (for example, sensor) is needed succeedingly.
[0005]
[Means for Solving the Problem] The system by this invention offers the short distance wireless data transmission from the CC point (for example, in terrorism GETA) to a cheap end point (for example, tag). An end point uses the modulation back KYATTA method for the communication to in terrorism GETA from a tag. A system uses a new up link protocol for the data transmission from in terrorism GETA to a tag at the data transmission from a tag to in terrorism GETA using a new down link protocol. The message in which any protocol does not have an Acknowledgement using a back off / retry algorithm is resent at random. The system capacity from a tag to in terrorism GETA improves further by use of up link subcarrier frequency multiplexing.
[0006]
[Embodiments of the Invention] Drawing 1 is the instantiation wireless-data-transmission (WDC (Wireless Data Communications)) system whole block diagram used for explaining this invention. The application processor 101 communicates with one or more in terrorism GETA 103 through a Local Area Network (LAN) or a wide area network

(WAN) 102. Although it is the point which should be careful of, a cable or radio is sufficient as a Local Area Network or a wide area network 102. In terrorism GETA 103 communicates with one or more cheap end points (on these specifications, it is called a "tag" for convenience.) 105. A tag 105 can be considered as the arbitrary electron devices which have information locally.

[0007] Generally in [explanation of communication technology] 1 ** application, in terrorism GETA 103 receives the data message 106 from the application processor 101. If it refers to in accordance with drawing 1 and drawing 2 , in terrorism GETA 103 will receive this data message 106, and will format a processor 200 into down link message, i.e., information signal, 200a which should be sent to a tag 105 correctly using the information included in the data message 106. The source 201 of a radio signal generates radio-signal 201a, and a modulator 202 modulates information signal 200a on radio-signal 201a, and forms modulating-signal 202a. A transmitter 203 transmits modulating-signal 202a to a tag 105 through the transmitting antenna 204 using amplitude modulation. The reason amplitude modulation is ordinary selection is because a tag can restore to this signal by the single cheap nonlinear device (for example, diode).

[0008] Drawing 3 is the block diagram of a tag 105. In a tag 105, an antenna 301 (in the cases of many a loop or a patch antenna) receives a modulating signal. It restores to this signal to baseband directly using a wave detector / modulator 302 (for example, considering as single schottky diode is possible.). A wave detector / modulator 302 restores to an input signal to baseband directly. Information signal 302a (this signal contains the same data as 200a) obtained as a result is amplified by amplifier 303, and a synchronization is recovered in the clock recovery circuit 304. Information signal 304a obtained as a result is sent to a processor 305. Generally a processor 305 is a cheap microprocessor and, on the other hand, can mount the clock recovery circuit 304 by ASIC (application-specific integrated circuit). A processor 305 can also be included by ASIC. A processor 305 generates the up link information signal 306 returned from a tag 105 to in terrorism GETA 103. This information signal is sent to the modulator controller 307. The modulator controller 307 modulates subcarrier frequency 308a generated by the source 308 of subcarrier frequency using an information signal 306. The source 308 of frequency is possible also for considering as another crystal oscillator, or its processor 305 is possible also for considering as the source of frequency (for example, master-clock frequency of a processor 305) drawn from a processor 305. The modulation subcarrier signal 311 is used in order to modulate radio carrier signal 204a received with a tag 105 and to generate a modulation back KYATTA (reflection) signal by the wave detector / modulator 302. This is realized by changing the reflection factor of an antenna 301 by turning schottky diode on and off using the modulation subcarrier signal 311. The power supply 310 of a cell or others supplies a power supply to the circuit of a tag 105.

[0009] An information signal 306 is generable by various methods. For example, the processor 305 in a tag 105 can use the attached input signal 320 as a source of a signal of an information signal 306. As an example of the information source using the attached input signal 320, there is a smoke detector 330, a temperature sensor 340, or a common sensor 350. There are few amounts of the data transmitted according to the attached input signal 320 depending on the case. In the case of a smoke detector 330, 1-bit information (is a smoke detector sounded or not?) is transmitted. In the case of a temperature sensor 340, a thermocouple 341 is connected to A/D converter 342 which generates the attached input signal 320. In the case of the common sensor 350, a sensor device 351 takes the logical circuit 352 and interface which generate the attached input signal 320. In this case, a logical circuit 352 has a very simple thing and a comparatively complicated thing depending on the complexity of the common sensor 350. An example of the common sensor 350 is a living body sensor which records human being's biological information (a heart rate, respiration rate, etc.). Such information can be periodically transmitted to the application processor 101, in order to carry out the monitor of the state of the living thing of human being or others continuously.

[0010] The technology of the [protocol whole structure] above is RF wireless-data-transmission technology of the minimum cost known by this contractor today. In order to design the wireless-data-transmission system which can support demand of communicating with many end points, time-slot structure like drawing 4 is used. The down link time slot i401 is a time slot by which information is transmitted to a tag 105 from in terrorism GETA 103. The up link time slot i402 is a time slot by which information is transmitted to in terrorism GETA 103 from a tag 105 using the above MBSs. In drawing 4 , although the length of the time of these time slots is illustrated so that equally, this condition is not a requirement of this invention. As for the persistence time of the down link time slot 401 and the up link time slot 402, it is possible for it not to be equal, either. Furthermore, in drawing 4 , although the time slot is illustrated so that one up link time slot i402 may continue after one down link time slot i401, this condition is not indispensable to this invention, either. A protocol can also support [also supporting the usage to which one up link time slot 402 continues after two or more down link time slots 401, also supporting that two or more up link time slots 402 continue after one down link time slot 401 possible, or] that two or more up link time slots (402) continue after two or more down link time slots (401) possible. In some applications, the data communication demand of the direction of a down link is large, and the determination of the exact number of the down link time slot 401 used in

some applications since the data communication demand of the up link direction is large, and the up link time slot 402 is left to each application designer. Although it assumes that the single up link time slot i402 continues after the single down link time slot i401 in the following explanation, this assumption does not restrict the generality of the method of this invention. Hereafter, a frame i403 is called present frame, and in this case, a frame i403 points out the combination of the down link time slot i401 and the up link time slot i402 following it, as shown in drawing 4 .

[0011] First, the data exchange (data transfer) from the tag 105 to in terrorism GETA 103 is explained. About the amount of the data which can be transmitted by the single up link time slot i402, it mentions later. When the amount of the data which want to transmit a tag 105 to in terrorism GETA 103 exceeds the possible maximum amount of data to the single up link time slot 402, a tag 105 transmits a packet until it packet-izes this data and every one of all data is transmitted within each up link time slot i402. Explanation of the following protocols is related with the method of transmitting and carrying out the Acknowledgement of such a single packet.

[0012] As already stated, communication of in terrorism GETA / tag uses amplitude modulation in a down link, and uses MBS in an up link. One communication path of operating rather than the path of another side at difficulty, i.e., a signal pair noise ratio low as an average, is not rarer in a bidirectional radio method. The down link communication in the application using MBS technology of it being more reliable than up link communication is not rarer. In order that up link communication may use a reflective radio signal in the reason, up link RF path loss is because it is the double precision of the one-way path loss to a tag 105 from in terrorism GETA 103. For this reason, since an up link message is received correctly, the element of the above-mentioned protocol reflects consideration that it may need to be repeated two or more times. However, this consideration does not restrict the general applicability of the protocol explained here.

[0013] The [up link data-exchange] above explained the physical layer of a radio communications system. Next, the protocol used in order to communicate information using this physical layer is explained. Drawing 5 is the schematic diagram of the up link data-exchange protocol 500. In the up link data-exchange protocol 500, the data with which to be transmitted to in terrorism GETA 103 is demanded exist in a tag 105. As for this data transmission having been received correctly, in the Acknowledgement message received with a tag 105, it is desirable for an Acknowledgement to be carried out by in terrorism GETA 103.

[0014] Drawing 5 is time line which shows transmission of each message as a function of time. In the up link data-exchange protocol 500, the up link data transmitting preparation completion 501 is the time when the tag 105 has recognized existence of data (information signal 200a) to transmit to in terrorism GETA 103 at, and moreover completed packet-ization of the above required data. The time of the up link data transmitting preparation completion 501 is time t505, and the time-slot (or frame) index 507 at that time is i. At this time, a tag 105 chooses Number NU. NU is the number which shows that this up link data packet containing all or a part of information signal 200a must be correctly received by in terrorism GETA 103 between the frames of NU individual. The value of NU is determined by the response-time demand of each application (after-mentioned).

[0015] A tag 105 calculates the random number set uj (j= 1, ..., J) with sequence after the up link data transmitting preparation completion 501. However, uj is distributed at random within a set (1 NU), there is no repeat in the value of uj, and the value of uj can be set in order so that it may be set to uj+1>uj to j contained inside (1 J-1). Then, in time-slot i+uj, in terrorism GETA 103 carries out the schedule of the transmission of J up link data 502 messages. These messages are up link transmitting 301a. It is assumed that the processor 200 of in terrorism GETA 103 can decode up link data 502 message at the time when the aforementioned message is received, and the guard time (after-mentioned) of the between at the time of the start of following time-slot i+uj +1. When up link data 502 message is received correctly (judged when CRC error detecting code is used for having been received correctly (after-mentioned)), and in terrorism GETA 103 transmits down link Acknowledgement 503 to a tag 105 in time-slot i+uj +1, the Acknowledgement of this message is carried out. Although it is the point which should be careful of, when a processor 200 cannot decode up link data 502 message at high speed such, down link Acknowledgement 503 is delayed to time-slot i+uj +2. This does not change a fundamental view.

[0016] Thus, the tag 103 knows that down link Acknowledgement 503 is expected to time-slot i+uj +1 (j is 1 in our example here.). When such down link Acknowledgement 503 is received correctly, the up link data-exchange protocol 500 does not need to terminate normally, and the up link data 502 remaining messages by which the schedule was carried out to next time-slot i+uj (j is 2 here) do not need to transmit it. RISUN [a tag 105 transmits the up link data 502 again in time-slot i+uj (j is 2 here) of the next value of j, and / that following down link Acknowledgement 503 is right to time-slot i+uj +1 (j is 2 here), and a tag 105 is received] when down link Acknowledgement 503 is not received correctly. When received correctly, the up link data-exchange protocol 500 terminates normally. When down link Acknowledgement 503 is not received to any of J up link data 502 transmitted messages, it is considered that the up link data-exchange protocol 500 is abnormal termination.

[0017] Next, selection of the above-mentioned parameter is explained. Based on the demand of application, length deltat of the time which the up link data-exchange protocol 500 must complete is determined. Although it is the point which should be careful of, NU is calculated by **(ing) deltat in time required of a frame i403. Next, selection of deltat is explained. being important -- online -- a monitoring system -- **** -- data -- an inn -- terrorism -- GETA -- 103 -- high speed -- needing -- having -- otherwise, -- the time -- a machine -- missing -- **** -- a sake -- being unnecessary - - ** -- carrying out -- having -- things -- it is -- that case -- deltat -- being small . In the case of the application of "batch-processing" mode of operation, although attainment of data is called for, since the hitting time of data is not not much important, the value of deltat can be considerably enlarged by it. In this case, the value of J is chosen so that protocol exchange of drawing 5 may be repeated several times at least. For example, J is set up equally to 5. Thereby, protocol exchange of drawing 5 is repeated 5 times.

[0018] The set of [radio range and interface] in terrorism GETA 103 assumes that it exists in a certain environment like drawing 1 . The reason of the existence of two or more in terrorism GETA 103 is guaranteeing guaranteeing normal communication with the perfect radio coverage 105, i.e., all tags, being performed within the environment. Since the down link message from two or more in terrorism GETA 103 is correctly received by the tag 105 depending on an environmental propagation property, the up link message from the specific tag 105 may be correctly received by two or more in terrorism GETA 103. In the above-mentioned up link data-exchange protocol 500, down link Acknowledgement 503 is transmitted to specific tag 105 **. It is rational that "near" in terrorism GETA 103 transmits the specific down link Acknowledgement 503 in the meaning are meaningful in the specific tag 105.

[0019] The number of in terrorism GETA 103 which transmits specific down link Acknowledgement 503 is restricted to in terrorism GETA 103 in the radio range of a tag 105. Thus, total system capacity increases by restricting transmission. It is assumed that in terrorism GETA 103 in the radio range of the specific tag 105 has transmitted same down link Acknowledgement 503 altogether for the purpose of this invention. Furthermore, you have to guarantee that those transmission does not interfere mutually. For example, down link Acknowledgement 503 is transmitted as mentioned above using amplitude modulation (AM). When transmission of two or more in terrorism GETA 103 in the radio range of the specific tag 105 overlaps, it interferes in an AM signal so that it may weaken and suit. Therefore, in terrorism GETA 103 assumes mutually that a time synchronization is carried out, in order to avoid such interference.

[0020] The case where the [down link data exchange], next data are transmitted to a tag 105 from in terrorism GETA 103 is considered. Drawing 6 is the schematic diagram of the down link data-exchange protocol 600. In this case, in terrorism GETA 103 packet-izes data (when required), and transmits the packet of data as down link data 602 in the down link time slot i401. As already stated, it is assumed that the time synchronization of the down link transmission of all in terrorism GETA 103 that is in a radio range mutually is carried out in order to avoid a mutual interference. In drawing 6 , the down link data transmitting preparation completion 601 arises in a time slot i. Then, in terrorism GETA 103 tends to transmit the down link data 602 as early as possible. If it assumes that the down link time slot i is vacant, in terrorism GETA 103 will transmit the down link data 602 by the time slot i. A tag 105 receives this down link data 602. Here, it is assumed that one time of the length of i403 is taken to judge whether the tag 105 decoded the down link data 602, and the message was received correctly (this is based on assumption that the processor 305 in a tag 105 is not powerful in about 200 processor in in terrorism GETA 103). Next, up link Acknowledgement 603 is transmitted to in terrorism GETA 103 by the time slot i+1 from a tag 105. In terrorism GETA 103 (it expects receiving up link Acknowledgement 603 by the time slot i+1.) judges whether up link Acknowledgement 603 was received correctly. When up link Acknowledgement 603 is received correctly, in terrorism GETA 103 transmits down link Acknowledgement 607 to a tag 105. The purpose of down link Acknowledgement 607 of this last is notifying to a tag 105 it not being necessary to transmit up link Acknowledgement 603 message further. The above-mentioned protocol acts correctly, when three messages 602, i.e., down link data, up link Acknowledgement 603, and down link Acknowledgement 607 are received correctly altogether. However, some message obstacles are expected in an actual radio channel. Therefore, in terrorism GETA 103 and a tag 105 all use two or more retry (retry) algorithms.

[0021] If it becomes the down link data transmitting preparation completion 601, in terrorism GETA 103 will carry out the schedule of the transmission of two or more down link data 602 messages. In order to perform this, in terrorism GETA 103 calculates the set dk (k= 1, ..., K) which consists of K random numbers with sequence. However, dk is distributed at random within a set (1 ND), there is no repeat in the value of dk, and the value of dk can be set in order so that it may be set to dk+1>dk to k contained inside (1 K-1). Parameter ND is chosen like the above-mentioned parameter NU. Next, in terrorism GETA carries out the schedule of the transmission of down link data 602 message in time-slot i+dk to k= 1, ..., K. Although it is the point which should be careful of, in the above-mentioned explanation, it is assumed that d1 is 1. That is, the first down link data 602 message is transmitted by the first empty down link time slot i401. It is an option in a protocol whether d1 is taken with 1. In this way, the schedule of the set which consists of K down link data 602 messages is carried out.

[0022] At the down link data-exchange protocol 600, selection of ND and K is the same as that of the selection of NU and J in the above-mentioned up link data-exchange protocol 500. Main views are that the schedule of the sequence of transmission of K down link data 602 messages is carried out, and ND is chosen from consideration of the time line of the data demanded by this specific application. A tag 105 carries out the schedule of the transmission of M up link Acknowledgement 603 messages for every transmission of down link data 602 message. Generally, the schedule of these up link Acknowledgement 603 messages is carried out so that it may be transmitted to the time NUD between time-slot i+dk and time-slot i+dk +1 (i.e., between two down link data 602 continuing messages). Therefore, NUD is small chosen from ND. Although it is rational to choose NUD with ND/K, this is only an example of the sorting by selection of NUD. when ND is divided into the set of K frames 403, the number of the frame 403 of these K sets which is alike, respectively and is contained is ND/K Parameter M is adjustable. The selection is dependent on the up link traffic need expected.

[0023] In drawing 6 , a down link data 602a message is transmitted to time-slot i+dk. When a tag 105 does not receive a down link data 602a message correctly, a tag 105 stands by the next down link data transmission. A tag 105 assumes this down link data 602 message to receive correctly. Then, a tag 105 carries out the schedule of the transmission of M up link Acknowledgement 603 messages. This is performed when a tag 105 calculates calculation **** for the random number set um (m= 1, ..., M) with sequence. However, um is distributed at random within a set (1 NUD), there is no repeat in the value of um, and the value of um can be set in order so that it may be set to um+1>um to m contained inside (1 M-1). A tag 105 determines by which time-slot i+dk+um up link Acknowledgement 603 is transmitted using these values of um. Two of M up link Acknowledgement messages (603a and 603b) are shown in time-slot i+dk+u1 and i+dk+u2 of drawing 6 .

[0024] It is assumed that in terrorism GETA 103 received correctly transmission of up link Acknowledgement 603b in time-slot i+dk+u2. Then, in terrorism GETA 103 transmits single down link Acknowledgement 607a in time-slot i+dk+u 2+1. When this down link Acknowledgement 607a is correctly received by the tag 105, a tag 105 cancels the transmission of the remaining up link Acknowledgement messages (for example, 603c) by which the schedule is carried out. When a down link Acknowledgement 607a message is not received correctly, in terrorism GETA 103 will resend down link Acknowledgement 607b once again, if the following up link Acknowledgement 603c is received correctly. All these processes are continued until each message of the down link data 602, up link Acknowledgement 603, and down link Acknowledgement 607 is received correctly.

[0025] The possible structure for transmission of [message structure] next a down link, and an up link is explained. Here, the structure which can use the same up link structure as the up link data 502 and up link Acknowledgement 603 possible [using the same down link structure as both down link Acknowledgement 503 and the down link data 602] is explained.

[0026] The down link message structure 700 is illustrated to drawing 7 . This shows the message segment and the number of bits relevant to a down link message. A message begins from a preamble 701. By the preamble 701, the clock recovery circuit 304 of a tag 105 becomes possible [synchronizing]. Next, the barker code 702 defines the start of the actual data of a message. In terrorism GETA ID 703 defines that in terrorism GETA has transmitted this signal. Although it is the point which should be careful of, it will interfere so that the data in in terrorism GETA ID703 segment are the same if all in terrorism GETA 103 is transmitting simultaneously, the data transmitted by the message segment when that is not right may be weakened and it may suit to all in terrorism GETA 103 that is in a radio range mutually. Next, the message to the tag which is different from each other is shown. The message to a tag 1 is shown in the three fields called the message 1 tag ID 704, message 1 counter 705, and message 1 data 706. The message 1 tag ID 704 is the identification number of the tag 105 of the destination of a message 1. Message 1 counter 705 is a message counter used since an Acknowledgement is made to each data message. Message 1 data 706 are actual data. This field can also be further enlarged depending on the property of application. The three same fields 704, 705, and 706 are repeated for every different message which should be transmitted to the n-th message of a down link message. It is 24-bit error correcting code CRC for which CRC707 is used in order to enable it to judge whether this down link message was correctly received for the tag 105. Although it is the point which should be careful of, the number of bits used with drawing 7 and the message structure of 8 expresses one possible mounting. For example, many numbers of bits are more nearly required for the message 1 tag ID 704 etc. than 16 bits in the system which has many tags 105 rather than 64,000 pieces. The size of message 1 data 706 is designed to a very small down link message like a simple Acknowledgement. In other applications, transmission of much more data may be needed in the direction of a down link.

[0027] The up link message structure 800 is illustrated to drawing 8 . A preamble 801 and the barker code 802 are the things of the same purpose as the down link message structure 700. A tag ID 803 is ID of a tag 105 which has transmitted this message. A message type 804 distinguishes whether this message is a data message or it is an

Acknowledgement. It is for the message counter 805 being the same as that of the above-mentioned message counter 705, and an Acknowledgement being made to each message. The tag message 806 is actual data and is 12 bytes in this case. In terrorism GETA 103 enables it, as for CRC807, for this message to judge whether it was received correctly.
[0028] Although it is the point which should be careful of, a data signal (also receiving the down link data 602 and down link Acknowledgement 503 like the up link data 502 and up link Acknowledgement 603, and a row) can be mounted using the completely same message structure using the above-mentioned down link message structure 700 and the above-mentioned up link message structure 800. Since the hardware for the same recovery and message analysis, a firmware, or software is applicable to a message arbitrary type by this, it is advantageous.
[0029] Moreover, the timing of the down link message structure 700 and the up link message structure 800 is effective if a certain guard time is introduced. Generally guard time is the time during the time of the end of one message by which the schedule was carried out, and the start of the following message. This time is introduced in order to compensate inaccuracy, such as timing and a synchronization, and clock precision.
[0030] The [interleave data-exchange] message counter 705 and the message counter 805 are used as follows. For example, in the up link data exchange 500, a tag 105 transmits up link data 502 message. In the message, the message counter 805 includes the value of 8 bits. In order that in terrorism GETA 103 may carry out the Acknowledgement to the up link data 502, when transmitting down link Acknowledgement 503, thereby, the Acknowledgement of the up link data 502 specific message is carried out including the value of 8 bits with message 1 same counter 705. This process is similarly applied to the down link data exchange 600.
[0031] If this capacity is given, it will become possible to extend the up link data exchange 500 like drawing 9 . In this example, a tag 105 transmits two or more data packets to in terrorism GETA 103. These packets are called the up link data k902 and up link data k+1 (904). Although it is the point which should be careful of, the down link data structure 700 has the capacity which carries out two or more Acknowledgements by same down link Acknowledgement 503 from drawing 5 and drawing 7 . First, a tag 105 transmits the up link data k902 to in terrorism GETA 103 by time-slot i+u1. A tag 105 expects receiving down link Acknowledgement 903 to time-slot i+u 1+1. However, it is assumed that this Acknowledgement is not correctly received in this case. (Since it is because in terrorism GETA 103 failed in reception of the up link data k902 receiving un-succeeding [of down link Acknowledgement 903], a tag 105 may depend it on reception of down link Acknowledgement 903 having gone wrong) this case -- a tag 105 -- next, it can choose transmitting the up link data k+1 (904) Next, a tag 105 assumes that down link Acknowledgement 905 is received. As shown in drawing 7 , the Acknowledgement of this down link Acknowledgement 905 can be carried out to the up link data k902, the up link data k+1 (904), or those both. Thus, by the method of carrying out the interleave of the Acknowledgement to data transmission, when two or more packets must be transmitted, high-speed transmission and the high-speed Acknowledgement of a message become possible.
[0032] When the up link message structure 800 is extended so that the Acknowledgement to two or more down link data 602 messages within one up link Acknowledgement 603 may be supported, it is possible to use the same procedure also for the down link data exchange 600.
[0033] In the case of a part of applications like the sensor network where many data are transmitted to in terrorism GETA 103 from a tag 105, it is advantageous to increase up link capacity rather than it is transmitted to a tag 105 from [increase of frequency multiplexing-up link capacity] in terrorism GETA 103. Such one method of an improvement of capacity is increasing the data rate of up link data 502 signal. However, since this method increases receiver bandwidth, it may reduce a signal pair noise ratio and may reduce the capacity and the range of a system. Another method of increasing system capacity, without reducing the range of a system is using frequency multiplexing. In drawing 3 , the source 308 of frequency generates subcarrier signal 308a. In frequency multiplexing, the source 308 of frequency can also generate which subcarrier frequency of the sets of possible subcarrier frequency. In the case of this protocol, specific subcarrier frequency assumes that it is chosen at random from the set of the possible subcarrier frequency by the source 308 of frequency to each up link message (for example, the up link data 502 or up link Acknowledgement 603). In this case, a protocol advances like the above.
[0034] The frequency space of the subcarrier signal 1000 is shown in drawing 10 . A tag 105 chooses subcarrier signal 308a (1 n) (referred to as fsi to i contained inside) from the set which consists of possible frequency of n pieces. In this case, the tag 105 with which it differs to n pieces can transmit an up link signal (either the up link data 502 or up link Acknowledgement 603) between the same up link time slots i402. In terrorism GETA 103 is a receiving antenna 206, and receives signal 301a including n up link signals. LNA207 amplifies an input signal on RF frequency. The rectangular mixer 208 restores to input-signal 301a to direct baseband using gay dyne detection. The output of the rectangular mixer 208 is I (inphase) of a signal and Q (rectangular cross) component to which it restored, and is shown by the signal 209 of drawing 2 . Drawing 10 shows the composition of the signal 209 over the channel of either I or Q. The bandwidth of each signal is deltaf1004. Going over the 1st subcarrier signal by (fs1-deltaf/2) to (fs1+deltaf/2), the

2nd subcarrier signal serves as a rear spring supporter etc. from (fs2-deltaf/2) by (fs2+deltaf/2). Although it is the point which it should be careful of here, all information signals are contained in the range from (fs1-deltaf/2) to (fsn+deltaf/2). Next, filter removal of the signal of the outside of this range is carried out using the filter amplifier 210. Next, the subcarrier demodulator 212 can restore to n up link information signals modulated on [of n pieces] subcarrier signal 308a simultaneously. There are two fundamental functions in the subcarrier demodulator 212. That is, it is filtering a signal further and recovering an information signal 306 from subcarrier signal 308a after that. In the one example, these two functions are performed in digital one and can be mounted by the digital signal processor (DSP) or the field programmable gate array (FPGA). The digital filter to each subcarrier signal 308a is adjusted to every subcarrier signal 308a. For example, a filter passes the frequency between (fs1-deltaf/2) and (fs1+deltaf/2) to 1st subcarrier signal 308a. The detail of the subcarrier demodulator 212 is shown in drawing 11 . An input signal 211 contains the channel of both I and the above-mentioned Q. The subcarrier filter 1110 performs filtering peculiar to subcarrier signal 308a (fs 1 and 1001). That is, this passes the frequency between (fs1-deltaf/2) and (fs1+deltaf/2). The subcarrier demodulator 1 (1120) lets the output of the subcarrier filter 1 (1110) pass. The subcarrier demodulator 1 (1120) recovers an information signal 306 from subcarrier signal 308a. An output signal 213 contains the information signal 306 from all the tags 105 which has transmitted the up link signal by subcarrier signal 308a which is different from each other at this time.

[0035] The result of this technology is as follows. The case of the up link data exchange 500 is considered. in this case, the thing for which the random number u1 within the range (1 NU) is chosen -- NU individual -- difference -- the up link time slot i402 is chosen When the flexibility of subcarrier signal 308a of n pieces is added further, the number of the selection which is different from each other increases as nxNU, and, thereby, up link capacity increases sharply potentially.

[0036]

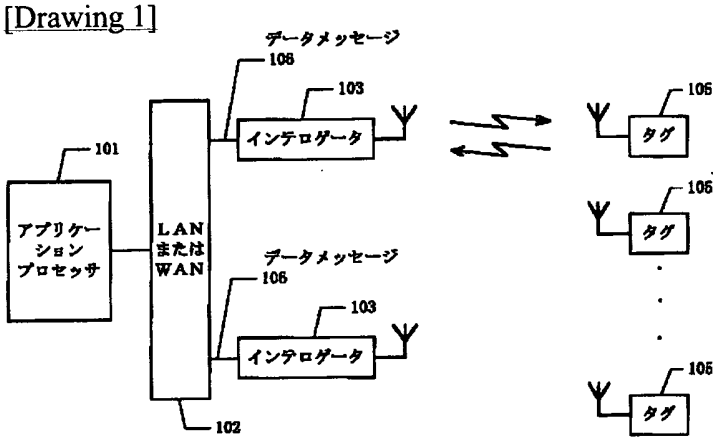
[Effect of the Invention] As stated above, according to this invention, the cheap radio data network which makes possible data communication to many cheap devices (for example, sensor) is realized.

[Translation done.]

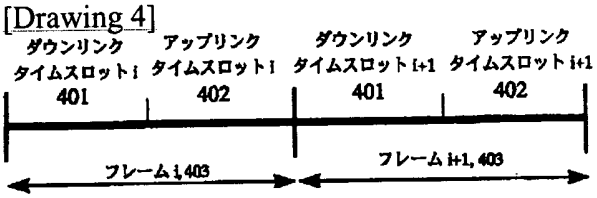
* NOTICES *

DRAWINGS

[Drawing 1]



[Drawing 4]



[Drawing 7]

ダウンリンクメッセージ構造 700

メッセージセグメント	ビット数
プリアンブル 701	11
バーカーコード 702	13
インテロゲータ ID 703	8
メッセージ$_1$タグ ID 704	16
メッセージ$_1$カウンタ 705	8
メッセージ$_1$データ 706	16
メッセージ$_n$タグ ID 704	16
メッセージ$_n$カウンタ 705	8
メッセージ$_n$データ 706	16
CRC 707	24

従って、ダウンリンクメッセージ長=56+40n ビット

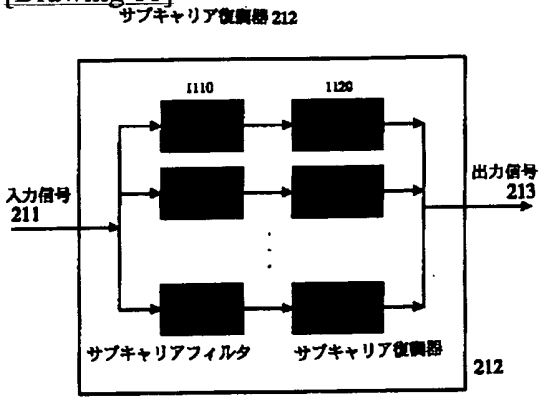
[Drawing 8]

アップリンクメッセージ構造 800

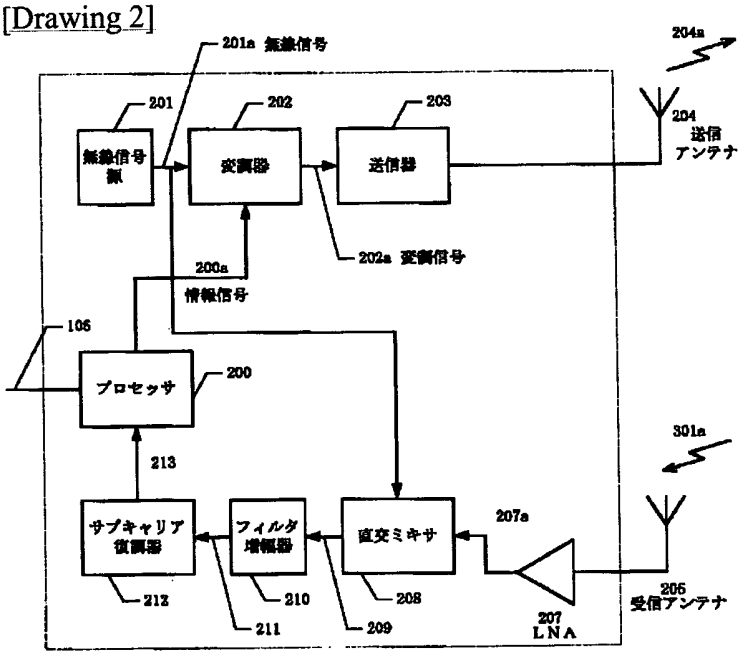
メッセージセグメント	ビット数
プリアンブル 801	11
バーカーコード 802	13
タグ ID$_1$ 803	16
メッセージタイプ 804	4
メッセージカウンタ 805	8
タグメッセージ 806	96
CRC 807	24

従って、アップリンクメッセージ長=172 ビット

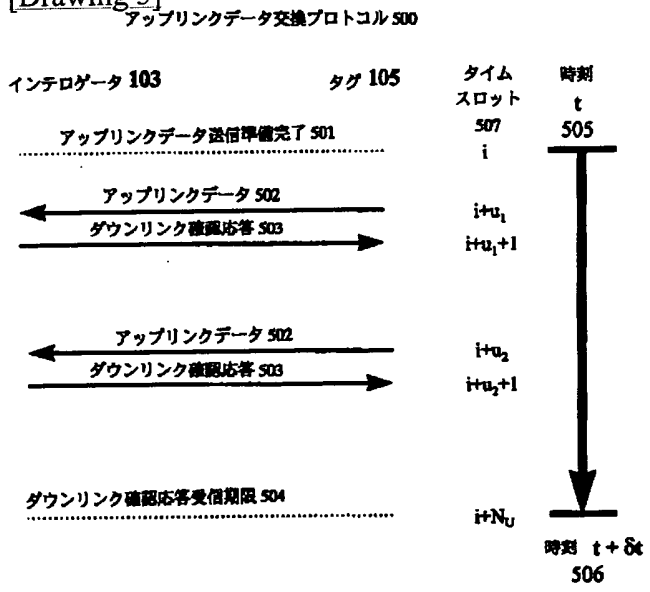
[Drawing 11]



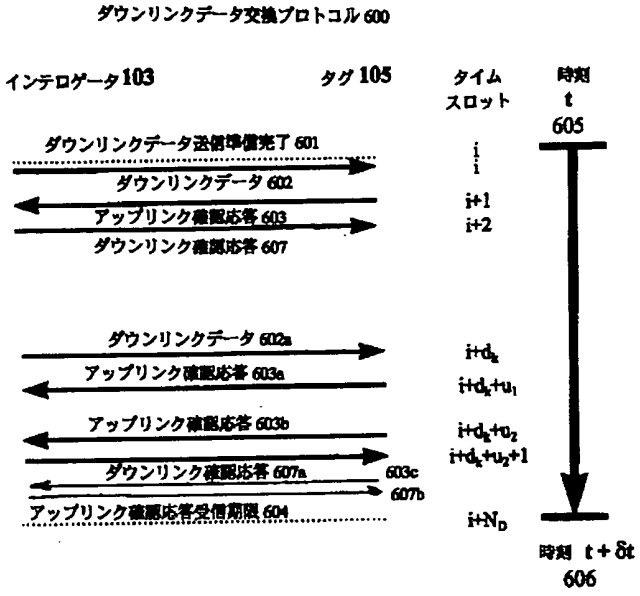
[Drawing 2]



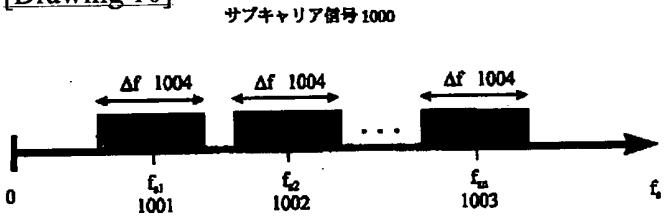
[Drawing 5]



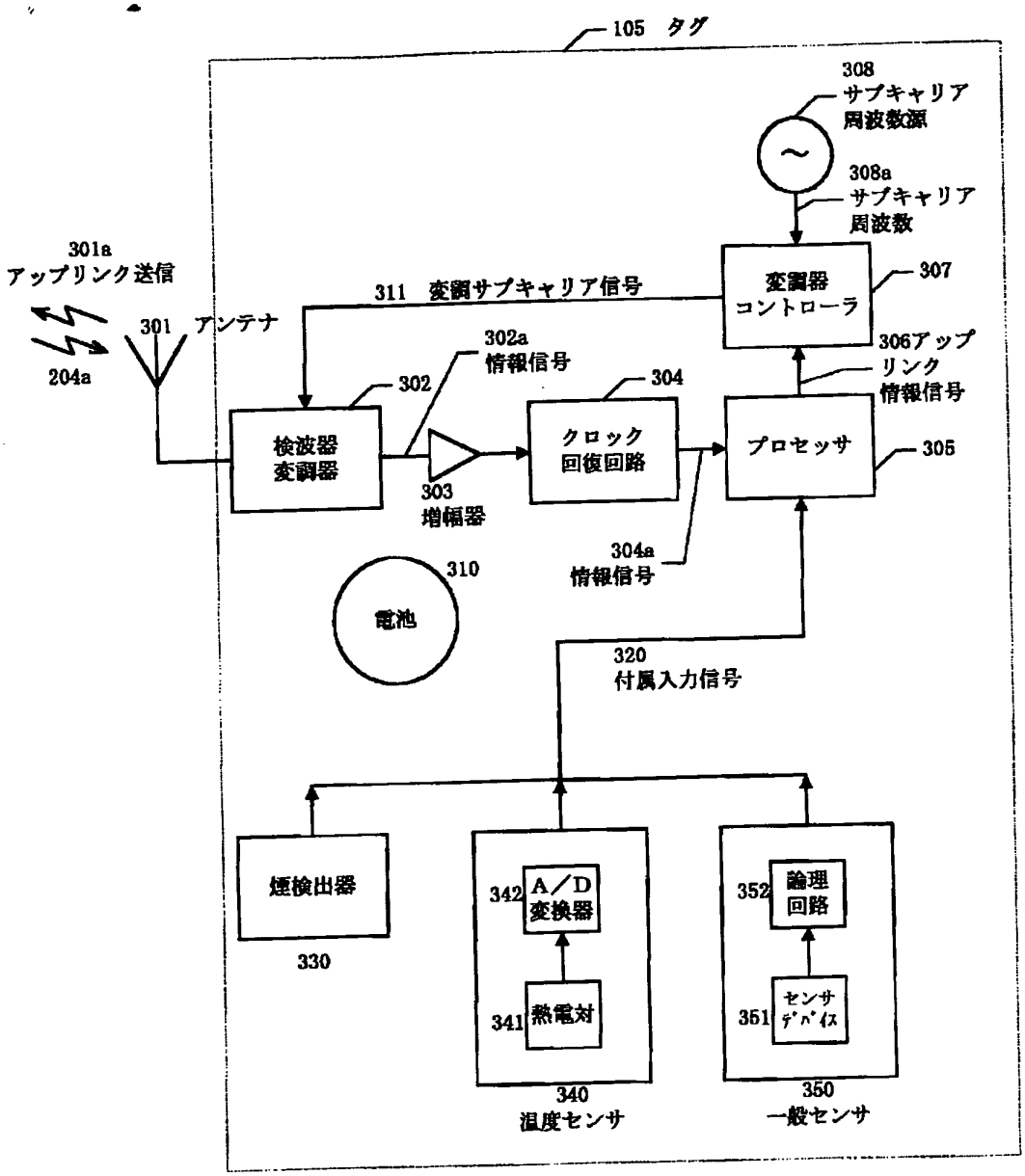
[Drawing 6]



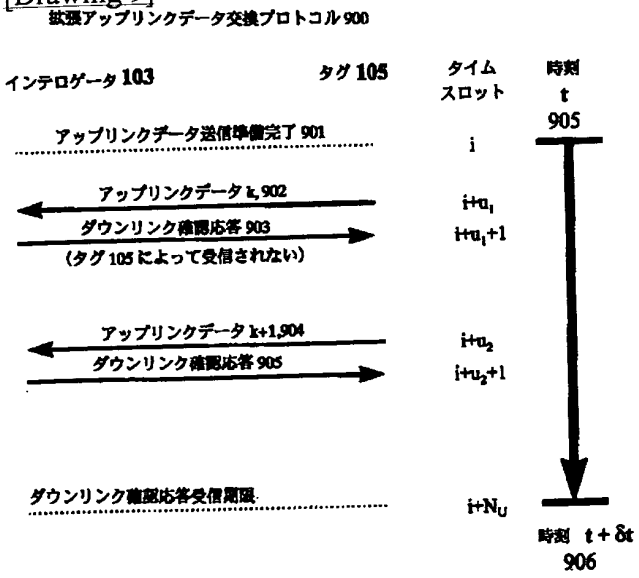
[Drawing 10]



[Drawing 3]


105 タグ
308
サブキャリア
周波数源
308a
サブキャリア
周波数
301a
アップリンク送信
311 変調サブキャリア信号
変調器
コントローラ
307
301 アンテナ
204a
302a
情報信号
306アップ
リンク
情報信号
302
304
検波器
変調器
クロック
回復回路
プロセッサ
305
303
増幅器
304a
情報信号
310
電池
320
付属入力信号
煙検出器
330
342
A／D
変換器
341
熱電対
340
温度センサ
352
論理
回路
351
センサ
デバイス
350
一般センサ

[Drawing 9]


拡張アップリンクデータ交換プロトコル900
インテロゲータ 103
タグ 105
タイム
スロット
時刻
t
905
アップリンクデータ送信準備完了 901
i
アップリンクデータ k, 902
i+u1
ダウンリンク確認応答 903
i+u1+1
(タグ 105 によって受信されない)
アップリンクデータ k+1, 904
i+u2
ダウンリンク確認応答 905
i+u2+1
ダウンリンク確認応答受信期限
i+NU
時刻 t + δt
906

[Translation done.]